Final Moody Creek Water Quality Monitoring Report

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Technical Report Summary
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Introduction

The Idaho Association of Soil Conservation Districts (IASCD) recently completed a monitoring project on Moody Creek in eastern Idaho. Moody Creek originates on the northeastern slope of the Big Hole Mountains within the boundary of the Targhee National Forest. The subwatershed is located in Madison County and is a major tributary to the South Fork of the Teton River. The South Fork of the Teton River enters the Henry's Fork of the Snake River approximately 12 miles below the confluence with Moody Creek.

The Teton River TMDL was written by the Idaho Department of Environmental Quality (DEQ) and approved by the Environmental Protection Agency (EPA) in February 2003. Several tributaries in the Teton River subbasin are on the state of Idaho's §303(d) list as being water quality limited. Moody Creek was listed specifically for nutrients. Pollutant targets for Moody Creek are given in Table 1. The beneficial uses that Moody Creek is designated to support are cold water aquatic life, salmonid spawning, agricultural water supply (AWS), industrial water supply (IWS) and wildlife habitat (WH).

This monitoring project was initiated at the request of the Madison Soil and Water Conservation District (SWCD). The project goal was to provide water quality data to the District to allow for identification of potential pollutant sources and to quantify pollutant concentrations in Moody Creek. The data will be used to plan implementation of voluntary agricultural best management practices (BMPs) throughout the Moody Creek subwatershed. IASCD has worked cooperatively with Idaho State Department of Agriculture (ISDA) and the Madison SWCD to implement this project.

Table 1. Pollutant targets for §303(d) listed segments in the Teton River TMDL.

Pollutant of Concern	Pollutant Targets for Teton TMDL
Total Suspended Solids	Not to exceed 80 mg/L, regardless of season
Total Nitrate + Nitrite	Not to exceed 0.30 mg/L
Total Phosphorus	Not to exceed 0.10 mg/L

Monitoring Schedule and Site Descriptions

Monitoring began April 2001 and continued through December 2004. Starting in April 2001, three locations were established on Moody Creek for water quality monitoring. An additional monitoring site, UMC, was added during April 2002 and was located approximately three miles downstream of the Targhee National Forest boundary and almost one mile downstream of state land (Figure 1). UMC is located in a relatively undisturbed area and was added to assess the "natural" conditions of Moody

Creek. Station UMC was not accessible in winter or during adverse weather conditions and the number of sampling events at this site was considerably less than at the lower three sites.

The lowest monitoring site, MC4, was located upstream of Moody Creek Road, directly above the road crossing. This site was accessible year round if it did not ice over in the winter. MC4 was the only monitoring site not located in Moody Creek Canyon. The next site upstream, MC3, was located on the upstream side of Pincock Road. This site was also accessible throughout the year, although during winter months sampling was often impossible because the stream was covered with ice. MC1 was located on the downstream side of the bridge at Wood's Crossing and at times this site is difficult to access due to steep terrain.

There are three irrigation diversions located on Moody Creek. The upstream diversion is located upstream of Woods Crossing, between the UMC and MC1 monitoring sites. The second diversion is located near the MC3 site and the third is the Woodmansee Canal diversion, below the monitoring sites. There are also three locations on Moody Creek where irrigation return flows enter the stream. The Enterprise Canal enters the creek above the MC3 site and both the East Teton and Teton Canals enter Moody Creek between the MC3 and MC4 sites.

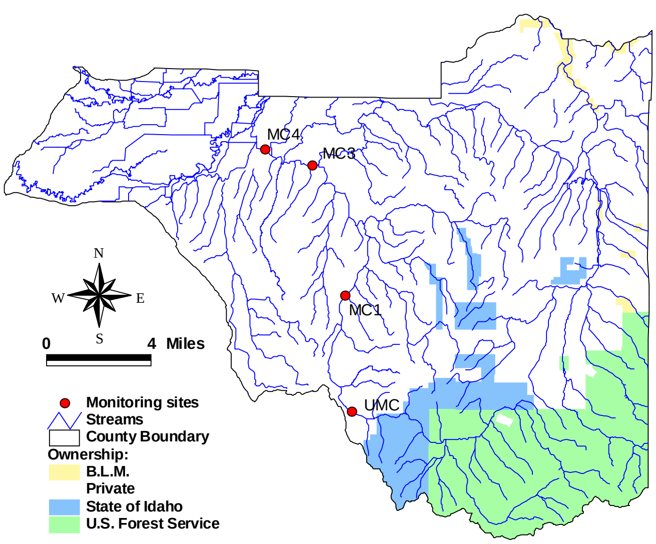

Figure 1. Moody Creek monitoring locations.

IASCD monitored twice a month throughout most of the year and once a month during winter. During each visit, samples were collected for total suspended solids (TSS), total volatile solids, total phosphorous (TP), orthophosphorus, nitrates + nitrites (NO_2 + NO_3) and ammonia. Field measurements were taken for stream discharge, temperature, dissolved oxygen, pH and conductivity.

Results

Discharge

Discharge rates in Moody Creek fluctuated seasonally as is common in systems that are largely influenced by snow melt. Stream flow peaked during spring months and declined to baseflows for the remainder of the year (Figure 2). Stream discharge rates in Moody Creek are also influenced by irrigation diversions and return flows (DEQ 2002). During the irrigation season flow may be diverted at three locations and the major irrigation returns to Moody Creek are Enterprise, East Teton and Teton canals.

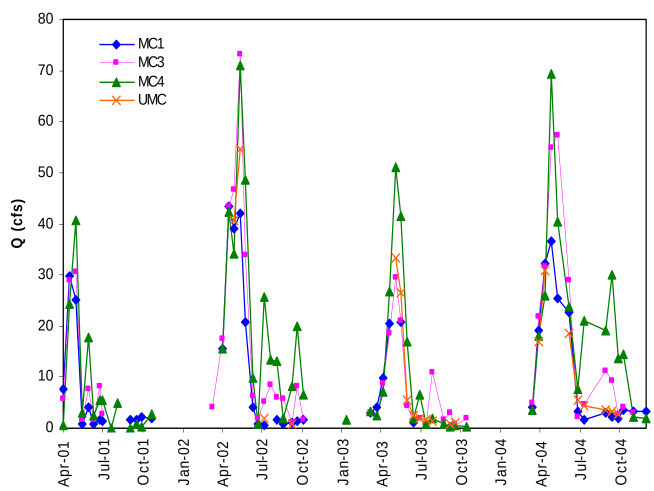

Figure 2. Stream discharge (cfs) at the four Moody Creek monitoring sites.

During 2001, MC1, MC3 and MC4 all experienced at least one period when stream discharge was zero. At times during the 2002 and 2003 seasons, the discharge rates at MC1 and UMC were insufficient to allow sample collection, but collections were made at sites MC4 and MC3 throughout 2002 and 2003.

Discharge rates were highest at the lowest Moody Creek site (MC4) and declined at upstream sites until the Upper Moody Creek (UMC) site, where a slight increase in stream flow was observed (Table 2). A decrease in discharge from the UMC site to MC1 was likely the result of an irrigation diversion between the two sites. An increase in stream flow from MC3 to MC4 was common during irrigation months and was likely the result of irrigation return flows from the two canals that drain into Moody Creek between the two sites.

Table 2. Mean, minimum and maximum stream discharge (cfs) and 95% confidence intervals.

Statistics	MC4	MC3	MC1	UMC
Mean (mg/L)	15.06	13.66	10.27	12.28
Min (mg/L)	0.05	0.65	0.32	0.75
Max (mg/L)	70.86	73.25	43.48	54.68
+/- 95 % CI	4.49	4.66	3.76	6.75

Total suspended solids

Total suspended solids (TSS) concentrations in Moody Creek fluctuated on a seasonal basis. As is common in snowmelt dependent systems, TSS levels increased significantly during peak runoff events and declined to low levels throughout the rest of the year. The DEQ target for TSS is 80 mg/L regardless of season, and all sites except UMC exceeded the target during spring runoff events. During the remainder of the year, TSS concentrations at each site were below the DEQ target.

Mean TSS concentrations at the four sites are given in Table 3. On average, the sites in Moody Creek were below the DEQ target of 80 mg/L, but differences between the four sites were apparent. TSS levels increased from the upstream to downstream sites. The sites found lowest in the subbasin (MC3 and MC4) experienced the highest TSS levels of all four sites. Site MC3 had the highest average TSS level and was located below a major irrigation return canal. MC4, which had the second highest TSS concentrations, was located below two irrigation return canals. TSS levels at the Upper Moody Creek (UMC) site never exceeded the DEQ target. The elevated TSS levels at MC3 and MC4 appear to be derived from the irrigation return flows and agricultural practices in the lower valley. Reductions in TSS levels could be achieved by implementing sediment reduction best management practices (BMPs) in the lower Moody Creek subbasin.

Table 3. Mean, minimum and maximum TSS concentrations (mg/L) and 95% confidence intervals.

Statistics	MC4	MC3	MC1	UMC
Mean (mg/L)	43.7	62.2	26.7	14.3
Min (mg/L)	3	1	1	2
Max (mg/L)	363	522	160	62
+/- 95 % CI	18.6	29.5	10.4	7.0

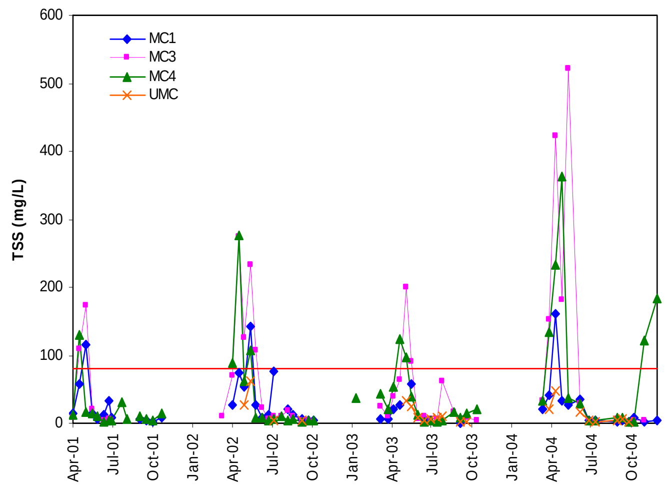

Figure 3. Total suspended solids (TSS) measured at four sites on Moody Creek from April 2001 to December 2004. The red horizontal line represents the DEQ target of 80 mg/L.

Total phosphorus

Total phosphorus (TP) concentrations in Moody Creek followed the same seasonal trend as total suspended solids (Figure 4). During peak runoff events TP was elevated above the DEQ target of 0.1 mg/L at the three lower sites, but was not exceeded at the Upper Moody Creek site. During baseflow conditions TP levels at the four sites were typically below the target, although samples at MC1 and MC4 occasionally exceeded the target during low flow conditions. TP concentrations at the UMC site never exceeded the 0.1 mg/L target.

On average, TP concentrations at the four sites were below the DEQ target (Table 4), but differences were still detectable at several monitoring sites. Phosphorus levels were significantly lower at the UMC site compared to the MC1 and MC3 sites. The lower three sites (MC1, MC3, MC4) were not significantly different from each other. Implementation of BMPs that target sediment reductions to the stream would also help to reduce phosphorus concentrations during spring runoff.

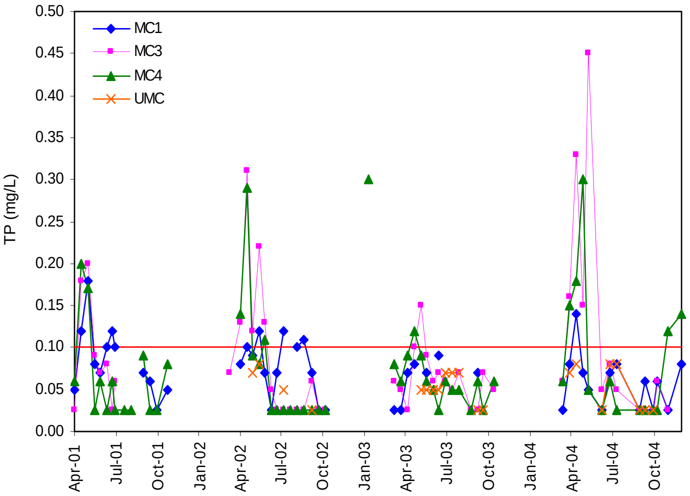

Figure 4. Total phosphorus (TP) measured at four sites on Moody Creek from April 2001 to December 2004.

Table 4. Mean, minimum and maximum TP concentrations (mg/L) and 95% confidence intervals.

Statistics	MC4	MC3	MC1	UMC
Mean (mg/L)	0.07	0.09	0.07	0.05
Min (mg/L)	0.03	0.03	0.03	0.03
Max (mg/L)	0.30	0.45	0.18	0.08
95 % CI	0.02	0.02	0.01	0.01

Discharge, TSS and TP Relationship

Discharge rates were highly correlated with total suspended solids and phosphorus concentrations in Moody Creek (Figure 5). The large influx of phosphorus during spring runoff events indicates that the phosphorus in Moody Creek is mostly in particulate form and enters the stream along with the sediment and organic matter it is bound to. The peaks and valleys in TSS and TP that correspond with increases and decreases in discharge suggest that there is not a chronic problem with either TSS or TP in Moody Creek, but a seasonal problem. BMP implementation that addressed water quality during spring runoff events could help reduce concentrations of both parameters during high flows.

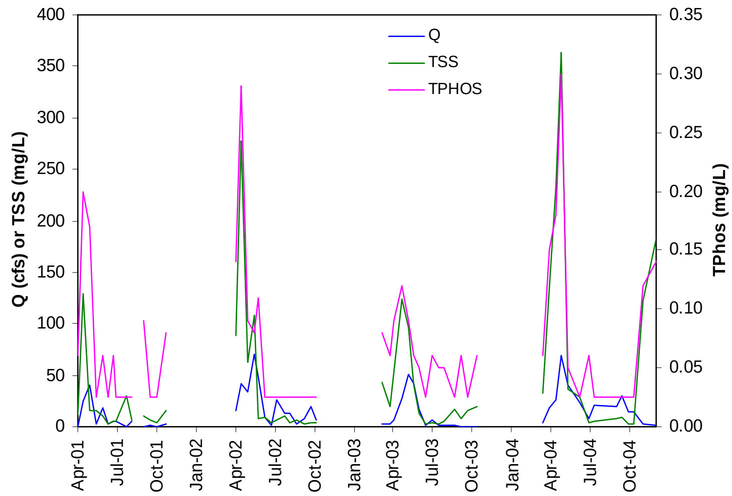

Figure 5. Total suspended solids (TSS) and total phosphorus (TP) in relation to stream discharge (Q) at site MC4 over the four years.

Nitrogen

Nitrogen (nitrate + nitrite, mg/L) concentrations measured in Moody Creek were often in excess of the DEQ target level of 0.3 mg/L. There were no obvious spatial or temporal trends in nitrogen levels (Figure 6). Average nitrate + nitrite concentrations at all four sites exceeded the DEQ target. Nitrogen concentrations were highest at the Upper Moody Creek site and declined significantly from the UMC site to MC1, the next site downstream (Table 5). This is contrary to what was expected. It was anticipated that UMC would have the lowest concentrations of all parameters because it is located directly below public land and has less visible agricultural impacts present.

During the first year (2001) of sampling, nitrogen concentrations at all sites were extremely low. Nitrogen levels during the last three years were elevated above the DEQ target (0.3 mg/L). We are unaware of any change in landuse practices that could explain this shift from very low to very high nitrogen levels. The source of elevated nitrogen should be further investigated through visual stream assessments and a review of historical landuse data. Because of the unexplainable discrepancy between years, the nitrogen data collected during the first year (2001) of sampling was excluded from this analysis.

DEQ measured nitrate levels in Moody Creek at several sites during the summer of 2000 and no samples exceeded the target 0.3 mg/L. DEQ reported that nitrate levels were highest at the lower reaches of

Moody Creek, downstream of the irrigation return canals (DEQ 2002). Data from this project shows the opposite trend, with nitrate levels decreasing from upstream to downstream sites. The data collected during this project reflects water quality in Moody Creek because it was collected over multiple years and across seasons, from 2002 – 2004.

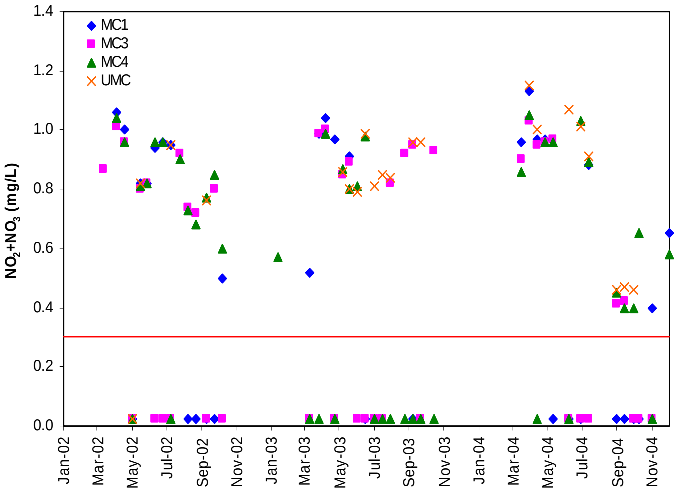

Figure 6. Nitrogen levels (nitrate + nitrite, mg/L) measured at four sites on Moody Creek from January 2002 to December 2004.

Table 5. Mean, minimum and maximum nitrate + nitrite concentrations and 95% confidence intervals.

Statistics	MC4	MC3	MC1	UMC
Mean (mg/L)	0.43	0.42	0.39	0.81
Min (mg/L)	0.03	0.03	0.01	0.03
Max (mg/L)	1.05	1.03	1.13	1.15
95 % CI	0.11	0.12	0.13	0.11

Conclusions and Recommendations

The seasonal elevation of total suspended solids and total phosphorus is common in snowmelt dependent systems. TSS and TP levels above the targets were restricted to spring runoff events and indicate that landuse practices in the valley are not significantly impacting water quality during much of the year. However, current practices may be increasing the availability or mobility of sediment during runoff events. Efforts to limit the input of sediment (and consequently phosphorus) during high flow events should be made by implementing sediment reduction BMPs in the lower Moody Creek drainage such as filter strips or riparian buffers. Simultaneous reductions in TSS and TP could be achieved using BMPs that target water quality during high flows.

The high nitrate levels at the UMC site are not easily explained. The high nitrogen may be due to cattle grazing that occurs on public lands above the site. If grazing was a major influence on water quality an increase in sediment (TSS) and total phosphorus (TP) would be expected at the site. Instead, the UMC site has the lowest level of TSS and TP and therefore the elevated nitrate levels cannot be fully explained by the presence of grazing livestock. Additionally, proper functioning condition estimates that were conducted on Moody Creek within the grazing allotment indicate that the riparian areas were in very good condition (Hancock 2000). This indicates that cattle grazing was not having a significant impact on the upper stream corridor.

The high nitrate levels at the UMC site may also be related to groundwater inputs. Nitrates move readily in groundwater and may be entering surface waters via groundwater springs. Moody Creek has several tributaries that are spring fed (i.e. Buck Spring on State Creek). Ultimately, the source is still unknown, but the potential influence of groundwater in the upper reaches of Moody Creek may indicate how nitrates are entering the system.

Excess nitrogen is the most chronic problem in the Moody Creek drainage. All sites we monitored exceeded the target for nitrate + nitrite (mg/L). Any attempts to decrease nitrogen inputs into Moody Creek should benefit the system. Efforts to decrease nitrogen inputs into the stream should be made by conducting nutrient management planning, irrigation water management planning and potentially building animal waste management systems and/or constructed wetlands for minimizing the impact of irrigation returns to the creek.

Acknowledgements
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Literature Cited

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